REPORT NO. 77-2-12

SEPTEMBER 1977
5200

AN EVALUATION OF INSECT DAMAGE IN SOUTHERN FEDERAL SEED ORCHARDS (1975-1976) (STUART - LA, ERAMBERT - MS, OUACHITA - AR, BEECH CREEK - NC, FRANCIS MARION - SC, AND OCALA - FL)

by

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INTRODUCTION

The production of superior seed from pine seed orchards is important in the southern United States because trees from this seed exhibit increased volume growth, improved form and fiber characteristics, and reduced disease incidence. These superior trees are being heavily relied upon to meet future timber production goals on fewer acres of timber lands. Federal seed orchards are just coming into production and are being depended upon to regenerate National Forest land with superior growing stock. Approximately 17,422 pounds of seed are needed annually from southern Federal seed orchards for this purpose.[4/] Only 1,115 pounds of improved seed were produced from the seed orchards in 1976.

Insects are the chief agent causing losses in seed orchards (Overgaard, et al., 1974) and, if not controlled, will adversely affect the availability of superior pine seed, thereby reducing future timber production. Currently, there is no technique for predicting population trends of seed orchard insects. Consequently, this evaluation is based on current seed, conelet, cone, and tip damage at the Ouachita, Stuart, Erambert, Francis Marion, Beech Creek, and Ocala Orchards and does not attempt to predict future losses.

Several insect species are involved in causing damage to seeds and cones. The reproduction potential of each insect species is not known. Any one species is capable of causing serious losses in any

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4/ Aycock, O. E. and R. E. Major. 1977. A Study of R-8 Seed Processing, Facilities, and Needs. R-8 Report.

given year and losses exceeding 90 percent of the possible seed crop are not unusual. It is estimated that half the potential crop is lost even in years when insect populations are relatively low.

Names of principle insect species, description of their biologies and behavior, and damage caused.

CONEWORMS, Dioryctria spp.

Coneworms, Dioryctria amatella (Hulst.), D. clarioralis (Walker), D. new species (abietella group), D. new species (Zimmermani group).

Biologies of coneworms are somewhat similar. Generally these insects attack the flowers, buds, and shoots, as well as the conelets and cones. Damage consists of larval tunnels with partly to totally excavated areas within infested structures (Ebel, et al., 1975).

Coneworms, depending on the species, have one to seven generations a year. Young, first instar larvae overwinter and attack flowers and shoots the following spring. Later in the summer, cones are attacked. Some species, like D. amatella, infest fusiform rust, Cronartium fusiform Hedg. & Hunt, galls and move to cones to complete their development.

PINE SEEDWORMS, Laspeyresia spp.

Three species are prevalent in the South: the slash pine seedworm, L. anaranjada Miller; the longleaf seedworm, L. ingens Heinrich; and the eastern pine seedworm, L. toreuta. Damage consists of larval feeding and development within maturing seeds and cones. Damage from these insects often prevents cones from opening, thereby affecting the extraction of seed.

In general, one generation occurs each year in all species of seedworms. The adults emerge in spring, mate, and the female moth lays eggs on cones. Eggs hatch in 3 - 6 days and young larvae bore into the cones. A larva enters a seed and completely consumes it and then bores into another seed. Each larva destroys one to seven seeds during its development and bores into the cone axis in the fall where it overwinters. The following spring the larva pupates and develops to an adult moth, which emerges through a hole in one of the excavated seeds.

SEEDBUGS, Leptoglossus corculus (Say) and Tetyra bipunctata (H.-S.)

These insects are sucking insects which feed upon developing conelets and seeds. Adults are strong fliers and nymphs are highly mobile, feeding on several conelets and cones during their life by puncturing them with their needle-like moth parts. Early stages are gregarious and may kill conelets and cones. They also puncture developing seeds and destroy the endosperm, causing empty or partially developed seeds.

Leptoglossus corculus overwinters as an adult. Eggs are laid in rows on pine needles. Several generations occur each year. Nymphs or early stages are present from April through October and adults can be found in spring, summer, and fall. In the deep South, the largest populations occur in July and August.

The shield back bug, T. bipunctata, overwinters as an adult in the litter. This insect has one generation a year. Adult populations may become quite high in late summer and early fall.

NANTUCKET PINE TIP MOTH, Rhyacionia frustrana (Comstock)

Larvae of the nantucket pine tip moth feed on tips of pines destroying primordial tissue in stem during summer, thus preventing conelet production the following season. They also feed directly on young flowers and conelets in early spring. Severe infestations may greatly retard growth and cause forking of small pine trees. Hosts are shortleaf, Pinus echinata Mill., loblolly, P. taeda L., Virginia, P. virginiana Mill.), and sand pine, P. clausa (Chapm.) Vasey. Slash pine, P. elliottii Engelm. var. elliottii, can be attacked; however, longleaf pine is resistant to this species of tip moth.

This moth has one to five generations with the most generations occurring in the southern part of its range. Moths emerge in late winter or early spring and lay eggs on new shoots and needles of pines. Upon hatching, larvae feed on young shoots or young flowers. About the third instar, the larvae bore into shoots where they pupate and complete development.

PINE CONEBORERS, Eucosma spp.

Eucosma cocana Kearfott, E. tocullionana Heinrich.

Damage is similar to that of Dioryctria spp., but the riddled white pine, P. strobus L., and shortleaf pine cones tend to be packed with a mixture of chewings and frass with no obvious tunnel system evident.

These insects usually have one generation a year. Moths emerge from pupae overwintering in the soil about April or May and lay their eggs. Young larvae tend to feed in groups in immature cones and later disperse and become more solitary in infested cones. Although they disperse, the larvae tend to concentrate within major branch systems so damaged cones are noticeably grouped within the tree crown. When mature (June-July), the larvae drop from the cones and pupate in the soil until the following spring.

WHITE PINE CONE BEETLE, Conophthorus coniperda (Schwartz)

The beetles attack the white pine cone at the cone base where it joins the stalk. A doughnut-shaped mass of resin-soaked light brown frass is formed around the entrance hole. Attacked cones wither and die. One insect may attack several cones.

Adult females emerge in early spring and attack and lay eggs in several cones during a 30-day period. The female beetle constructs a gallery down the cone axis and lays eggs in from one to 24 nitches in the gallery wall. The larvae feed on both cone and seed tissues. When cones are scarce, conelets are attacked, but no eggs are laid in them. One generation occurs yearly and adults overwinter in infested cones.

BIOLOGICAL EVALUATION SURVEY

Cone and conelet loss was determined by tagging 10 percent, or a minimum of 10 clusters, on each sample ramet of a number of preselected clones in treated and untreated areas. Monthly observations of individual structures were made throughout the growing season so as to determine time and cause of losses. When tagged cones were mature, they were collected and the seed extracted and x-rayed. Such monitoring studies were conducted at the Stuart, Ouachita, Beech Creek, and Erambert Orchards.

Additionally, second year cone losses were assessed on some geographical sources at the Ouachita, Erambert, and Beech Creek Orchards by harvesting 100 percent of the cones and counting damaged and undamaged cones from each sample ramet of selected clones in sprayed and unsprayed areas.

Five or six apparently sound cones were collected from each sample ramet. The cones were dried using warm air and then the seed extracted by two methods: First, by shaking individual cones by hand and then by dissection. Seeds extracted by each method were x-rayed separately; however, for this report, x-ray data for both extractions was combined. X-rays were interpreted for sound seed, empty seed, seed bug damaged seed, and malformed seed. Percent of sound seeds was used for comparison. Most empty seed was considered caused by seed bugs feeding.

SOSET (Seed Orchard Seed Evaluation Testing) data from the Eastern Tree Seed Laboratory, Macon, Georgia, was used to assess damage at the Beech Creek and Francis Marion Orchards. SOSET provides a measure of seed production, viability of the extracted seed, and a radiographic analysis of the extracted seed. The radiographic analysis identifies insect problems, abnormal seed development, and the percentage of filled seed. This method is considered a continual monitoring technique.

The Ocala Orchard was established exclusively for the production of sand pine superior seed and is expected to begin production next year. The main tree associates present to date are the Nantucket pine tip moth, aphids, Cinara sp., and the pine tortoise scale, Toumeyella numismaticum, (Pettit and McD). Cone collections made on the periphery of the orchard last year indicates the potential for insect-caused seed damage.[5/]

5/ Wolfe, R. D. Letter to B.F. Finison, N.F. in FL, April 29, 1976 - 5200.

An evaluation of tip moth, aphid and scale damage was conducted on this orchard on June 17, 1977. A total of 20 clones with two ramets per cone were sampled each in a sprayed and check area on the orchard for a total of 80 trees sampled. Data were taken for tip moth damage to the terminal, to the first whorl (4 laterals), and for the presence of Cinara sp. aphids and pine tortoise scale.

Percent healthy tips at the Ouachita and Stuart Orchards was determined by examining the top 20 tips on each ramet being monitored for seed and cone insect control.

Where appropriate, data were subjected to ANOVA and Duncan's New Multiple Range test.

Insecticide treatments to seed orchards are summarized in table 1.

RESULTS AND DISCUSSION

Ouachita Orchard - AR

A monitoring study in the shortleaf pine Ozark geographical source revealed that conelet-cone survival for a two-year period was highest (37.5 percent) for the DiSyston® treatment and lowest (14.4 percent) for the Cygon®-Guthion® treatment (Cygon applied to conelets in 1975--Guthion to cones in 1976) (table 2). The reason for the lower cone survival for the Cygon-Guthion treatment may be due to possible phytotoxic effects of Cygon. Percent second-year cone loss during 1976 for the Cygon-Guthion treatment was considerably less (23.7 percent) than that for the check (40.9 percent). There was 19.0 percent cone loss on the DiSyston-treated pines.

The percent sound seed for the Cygon-Guthion treatment (67.9) was double that of the check (32.0), and the number of sound seed per cone was more than tripled (table 2). Seed efficiency was 44.9 percent for the Cygon-Guthion treatment and only 13.2 percent for the untreated pines. Seed efficiencies of less than 50 percent are considered poor by the Eastern Tree Seed Laboratory. Tip moth damage on checks and treated trees was light during 1976 when compared to 1975. An August 1977 evaluation showed 82 percent and 91 percent healthy tips in check and Guthion-spray areas, respectively.

A collection of cones from two ramets of each of four clones in a Cygon-Guthion treated area in the east Ouachita source revealed an average 87.7 percent sound seed and 76 full seed per cone. This is probably close to seed potential comparing it with the average seed potential of 85 seed per cone on the five clones from the Ozark source.

Table 1. Summary of insecticide treatments at the southern Federal Seed Orchards during 1976.

Orchard	Insecticide	Acres	Rates	Dates Applied
Ouachita	Cygon 2E	300	4 pts/100 gal H_2O	4-5 to 4-16
	DiSyston 15G	100	2½ oz/in d.b.h.	March
	Guthion 2S	300	12 to 30 pts/100 gal H_2O	6-1 & 6-17
				7-5 to 7-16
				8-30 to 9-14
Stuart	Guthion 2S	200	8 pts/100 gal H_2O	5-4 to 5-19
				6-2 to 6-9
				7-6 to 7-12
				8-2 to 8-6
				9-1 to 9-8
Erambert	Guthion 2S	180	12 pts/100 gal H_2O	4-26 to 6-2
				6-2 to 8-12
				8-12 to 8-26
	Furadan 10G	2	8 oz/in d.b.h.	February 1/
Beech Creek	Scaleacide			February
	Dormant Oil			February
	Thimet			February
	Cygon			April
				May
				June
	Cygon 2E			July
	Malathion			July
	Thiodan			August
	Sevin			August
Ocala	Cygon 2E			June 1 1977
				July 1
				August 8
Francis Marion	Sevimol			April
	Cygon			June
				July
	Guthion		6 pts/100 gal H_2O	May
				June
				July
				August

1/ Zip Seeder Evaluation

Table 2. Conelet, cone, seed, and tip survival on monitoring studies of DiSyston and Cygon-Guthion treatment conducted on shortleaf pines at the Ouachita Seed Orchard, Mt. Ida, Arkansas, 1975-1977.

Treatment[1/]	Conelets - Cones			Seed						
	% conelet survived Feb. '75 to Oct. '75	% conelets & cones survived Feb. '75 to Oct. '76	% cone loss 1976	% sound seed	sound seed/ cone	seed[2/] potential	seed[3/] efficiency	% healthy tips[4/] Oct. '75	% healthy tips[4/] Oct. '76	% healthy tips[4/] Aug '77
DiSyston[5/]	37.5a[6/]	30.5a	19.0	55.8a	20.8a	85.0	24.4	63.0	97.0	-
Cygon-Guthion[7/]	18.9b	14.4a	23.7	67.9a	38.2a	85.0	44.9	55.0	98.0	91
Check-untreated	27.0b	16.0a	40.9	32.0a	11.3a	85.0	13.2	33.0	92.0	82

1/ Data based on 5 clones with 2 ramets from each clone with 10% or a minimum of 10 conelet clusters per tree tagged in Feb. 1975.

2/ Seed potential = No. of fertile scales/cone x 2. Based on 5 cones collected from each of 2 ramets of 5 clones or a total of 50 cones.

3/ Percent of potential seed production or sound seed per cone divided by seed potential.

4/ Based on the top 20 tips on each ramet in the monitoring evaluation.

5/ DiSyston 15% granular applied by a fertilizer spreader at the rate of 2.5 oz./in. of tree diameter and disked into the soil.

6/ Treatment means in the same verticle column not followed by the same letter are significantly different.

7/ Four treatments of Cygon 2E/4 pints per 100 gal. water in 1975. Four treatments of Guthion 2S per 6 pints/100 gal. in 1976.

Stuart Orchard - LA

Shortleaf (Furadan® timing)

Cones and conelets tagged on four shortleaf pine clones (2 ramets/clone) in February 1976 were monitored until October 1976 on a study in which comparison of October '75 and February '76 treatments of Furadan 10G® (12 oz/in tree dia.) were compared. This rate exceeds the highest (8 oz) registered rate of Furadan. Percent conelet survival was highest (64.5 percent) for the October treatment and percent healthy tips highest (71.3 percent) for the February treatment (table 3). The February treatment showed the highest percent (74.9) sound seed and double the numbers of sound seed (44.6) per cone over the check (47.2 percent sound seed; 18.9 sound seed/cone). Seed efficiency was 40.5 percent for the February treatment, 28 percent for the October treatment, and 17 percent for the untreated check.

Overall conelet and cone losses, excluding man-caused losses, were reduced on both February and October Furadan treatments (tables 4 and 5). An analysis of variance was conducted on tip moth losses for the three treatments; however, these differences were not significant. Coneworm damage was reduced by both Furadan treatments.

Loblolly (Cygon-Guthion, Fertilization, Check)

Conelet survival was the highest (61.9 percent) for the fertilization treatment and lowest (38.2 percent) for the Cygon-Guthion treatment (table 6). Conelet-cone survival in the fertilization treatment was significantly different from the check and spray in 1975 (table 6); however, conelet survival for the fertilization treatments (56.2 percent) was less than for the check 65.2 percent) in 1976. Percent conelet survival for the Cygon-Guthion treatment was less than the check during 1975. This loss occurred before insecticide treatments were initiated during both years. Therefore, it is believed that other factors were involved.

Overall, second year cone losses in the check area were only slightly higher than those in the treatment area. Cone loss was higher in the check area than in the Guthion spray area (13.0% in the check vs 8.7% in the spray). Percent sound seed from the spray area was on the average 14.8% higher than that from the check, and numbers of sound seed per cone from the sprayed area was 1.6 times higher than the check (table 6). Seed efficiency was fair (52.0%) on the Cygon-Guthion treatment and poor on the fertilizer treatment (20.7%) and untreated check (31.6%).

Erambert Orchard - MS

The evaluation at the Erambert Orchard was based partly on a monitoring study on the southern Mississippi loblolly source on which first year flowers were tagged and partly on cone collections from various seed

Table 3. Conelet, cone, seed, and tip survival on February and October Furadan applications and untreated areas on shortleaf pines at the Stuart Orchard, LA 1976.

	Conelets & Cones		Seed				Tips
	% conelets[1] survived Feb. '76 - Oct. '76	% cones survived Feb. '76 - Oct. '76	% sound seed	sound seed/cone	seed[2] potential	seed[3] efficiency	% healthy tips[4] Oct. '76
Check-untreated	42.6	86.0	47.2	18.9	103	17.0	62.2
Furadan (Feb.)[5]	53.5	89.2	74.9	44.6	103	40.5	71.3
Furadan (Oct.)[6]	64.5	93.6	55.8	30.8	103	28.0	64.4

1/ Data based on 20% of conelets tagged in February 1976.

2/ Seed potential = No. of fertile scales multiplied by 2. Based on 5 cones collected from each of 2 ramets of each of 4 clones.

3/ Percent of potential seed production or sound seed per cone divided by the seed potential.

4/ Based on the top 20 tips of each ramet.

5/ 12 oz/in d.b.h. applied by hand and watered in in February 1976.

6/ 12 oz/in d.b.h. applied by hand and watered in in October 1975.

Table 4. Percent conelet losses on Texas shortleaf by causal agent between February 1976 and October 1976 on Furadan treatments at the Stuart Orchard, Pollock, LA.

Treatment	Total[1/] loss (except man-caused)	Cone-worms	Tip-moths	Other & unknown insects	Unknown causes	Missing	Abort	Man-caused
Check	53.3	0.2	5.7	11.0	4.1	14.4	17.9	4.1
Furadan (Feb.)[2/]	45.2	0.0	4.3	8.9	0.9	21.0	10.8	1.3
Furadan (Oct.)[3/]	35.5	0.0	0.0	10.7	1.3	11.8	11.7	4.2

1/ Data based on 20% of conelets on 2 ramets each of 4 clones in each treatment.

2/ 12 oz/in d.b.h. applied by hand and watered in in February 1976.

3/ 12 oz/in d.b.h. applied by hand and watered in in October 1975.

Table 5. Percent cone losses by causal agent on Texas shortleaf between February 1976 and October 1976 at the Stuart Orchard, Pollock, LA.

Treatment	Total[1/] (except man-caused)	Cone-worm	Unknown insects	Unknown causes	Missing	Abort	Man-cuased
Check	11.0	4.0	3.0	3.0	1.0	0.0	3.0
Furadan (Feb.)[2/]	3.6	0.0	1.8	0.0	1.8	0.0	7.2
Furadan (Oct.)[3/]	4.2	0.0	4.2	0.0	0.0	0.0	2.2

1/ Data based on 20% of conelets of two ramets of each of 4 clones tagged in February 1976.

2/ 12 oz/in d.b.h. applied by hand and watered in in February 1976.

3/ 12 oz/in d.b.h. applied by hand and watered in in October 1975.

Table 6. Conelet, cone, tip, and seed survival on Cygon-Guthion, fertilization and check treatments on loblolly pines at Stuart Seed Orchard, 1975-1976.[1/]

	% conelets tagged Feb. '75 survived to Oct. '76	% conelets tagged Feb. '76 Survived to Oct. '76	% conelets damaged (coneworms) 1976	% cones lost during 1976	% sound seed	sound seed/cone	seed[2/] potential	seed efficiency	% healthy tips '76
Cygon-Guthion[4/]	38.2b	70.6	0.0	8.8	76.9	62.9	121	52.0	98.1
Heavy Fertilization[5/]	61.9a	56.2	4.5	8.7	31.5	25.0	121	20.7	93.1
Check-untreated	52.8b	65.2	7.6	13.0	62.1	38.2	121	31.6	82.5

1/ Data based on 20% of conelets tagged in Feb. 1975 and 20% tagged in Feb. 1976 of 2 ramets of each of 4 clones in each treatment or a total of 32 trees. Tip data is based on top 20 tips examined in Sept. 1976.

2/ Seed potential = No. of fertile scales multiplied by 2. Based on 5 cones collected from each of 2 ramets of each of the 4 clones.

3/ Percent of potential seed production or sound seed per cone divided by seed potential.

4/ Cygon 2E (4 pints/100 gal. H_2O) applied as a drench in three applications in May, July, and August 1975 and Guthion 2S (6 pints/100 gal. H_2O) applied in three applications as a drench in 1976.

5/ Equivalent of 600#/acre of 12-12-12 fertilizer applied in April during 1972-1976.

6/ Based on top twenty tips of each ramet.

sources. Percent first year flowers survived on the southern Mississippi loblolly Guthion-treated area was 9.5 percent greater than that for the check (table 7). There was no difference in mature cone damage between sprayed and unsprayed. Twenty percent more sound seed was produced from cones from sample clones on sprayed areas in this source than check areas.

The Florida slash spray area experienced 7.3 percent more insect damage to mature cones than did the check. However, it is not known what percentage of this damage was due to coneworms. Overall, percent coneworm damage on the orchard was low. Percent sound seed was relatively high on sprayed areas on nothern Mississippi loblolly, Mississippi slash, and Mississippi longleaf sources (table 7). Eleven percent more sound seed was produced on the Florida slash sprayed area than the check area.

Three times as much coneworm damage on loblolly pines occurred on check areas as on Furadan-treated areas and three times as much full seed per cone was produced on Furadan treatment as on checks (table 8). Although only a small difference in identifiable seed bug damage occurred between checks and treatments, most of the empty seed was probably due to seed bug damage.

Beech Creek Orchard - NC

Fifty-five percent of the conelets tagged on Virginia pines in 1975 survived to maturity according to a cone and seed insect impact study at the Beech Creek Orchard. Approximately 30 percent more sound seed was produced from cones on areas sprayed with Guthion than on check areas.

In tests using carbofuran on white pines, all rates of this material tested (4, 8, and 12 oz/in d.b.h.) were significantly different from the check as regards percent full seed, percent empty seed, percent seed bug-damaged seed, and numbers of seeds per cone (table 9). Furadan 10G at rates of 4, 8 and 12 ounces showed an increase of 117, 180 and 140 percent increase in seed yield, respectively, over the untreated check.

Francis Marion Orchard - SC

X-ray data from the Eastern Tree Seed Laboratory of samples of 2,877 loblolly seeds from a check area and 3,403 seed from a Guthion-sprayed area showed approximately 18 percent more sound seed produced in sprayed areas (66.5%) than check areas (48.9%). No information on cone damage was available for this orchard.

Ocala Orchard - FL

It is noted that although there was 10 percent less damage on the first whorl (4 laterals) on the sprayed area than on the check, there was no difference between check and spray areas with regard to damage to the terminal (table 10.) Aphid infestation level in sprayed areas was greater

Table 7. Results of cone and seed insect monitoring at the Erambert Orchard, MS. 1976.

	% Flowers survived September[1/]	% insect damage to mature cones[2/]	% sound seed[3/]	sound seed/ cone
S. Miss. Loblolly (Spray)[4/]	73.5	4.2	36.2	41
S. Miss. Loblolly (Check)	64.1	4.5	16.2	26
Fla. Slash (Spray)	-	9.2	69.0	-
Fla. Slash (Check)	-	1.9	58.0	-
Ala. Loblolly (Spray)	-	6.9	31.7	-
Mississippi Loblolly (Spray)	-	0.0	71.1	-
Mississippi Slash (Spray)	-	0.6	71.5	-
Mississippi Longleaf	-	0.0	65.6	-

1/ Based on sample of 10 percent on a minimum of 10 flowers tagged on 2 ramets of each of 4 clones in each treatment in March 1975.

2/ Based on all of cones collected from sample trees.

3/ Based on x-rays of seed collected from six apparently sound cones collected from sample trees.

4/ Spray consisted of six pints of Guthion 2S/100 gallons of water applied as a drench spray, applied in May, June, and August.

Table 8. Cone and seed insect damage on Southern Mississippi loblolly pines treated with Furadan at the Erambert Seed Orchard, 1976.

Treatment	% *Dioryctria* spp. infested cones	% sound seed	# full seed/ cone	% seed-bug damaged seed	% seed-worm damaged seed	% empty seed
Furadan (Zip seeder)[1/]	3.7	53	41	0.3	0	42
Furadan (Disk)[1/]	2.7	55	48	0.1	0	45
Check	9.7	19	14	0.8	5	75

1/ 8 oz. of Furadan 10% granular applied per inch of tree diameter in February 1976.

Table 9. 1976 carbofuran test seed data -- USFS Beech Creek White Pine Seed Orchard, Murphy, N.C.

Treatment	Oz. 10G/ in. DBH[1/]	Radiographic Analysis			Yields		
		Full	Empty	Seedbug-damaged	Seeds/ cone	Full Seeds/ cone	Increase
		----------Percent----------			----------Number----------		Percent
Check	0	46.0a[2/]	48.2a	5.8a	22.1a	10.7a	---
Furadan	4	73.8b	24.4b	1.8b	31.2b	23.2b	117
Furadan	8	81.7b	17.5b	0.8b	36.5b	30.0b	180
Furadan	12	79.2b	20.2b	0.5b	32.0b	25.7b	140

1/ Applied 2/23/76.

2/ Means not followed by the same letter in the same verticle column are not significantly different from each other at the 1.0 percent level.

Table 10. Pine tip moth, aphid, and scale damage on the Ocala Seed Orchard, June 1977.

Insect damage[1/]	Percent damaged or infested branches Sprayed	Unsprayed
Tipmoth damage		
a) Terminal	12.5	12.5
b) First whorl (4 laterals)	5.0	15.0
Aphids (*Cinara* sp) infested	7.5	0.0
Pine tortoise scale infested	2.5	2.5

1/ Twenty clones sampled; 2 ramets/clone

2/ Sprayed with Cygon 2E, 4 pints/100 gal H_2O

than in check areas. There was no difference in scale infestation level in the check and spray areas.

SUMMARY

Coneworm infestation levels were low in all orchards during 1976. Highest recorded damage was 13 percent on the Louisiana loblolly check area at the Stuart Orchard. Percent sound seed was highest on the Guthion-treated area on the Louisiana loblolly source at Stuart. The greatest difference in percent sound seed between a treated area and check area was at the Ouachita Orchard with 67.9 percent on the Cygon-Guthion treatment and 32.0 percent on the check.

A large difference in cone damage was not always shown between treatment and check areas. However, infestation level may have been somewhat reduced in check areas as well because of the reduction of seed and cone insect population in orchards as a whole.

Considering protection to conelets, cones, and seed, a conservative estimate would be twice the quantity of seed is being produced on treated areas as on check areas.

Seed bugs are not a target of the Guthion spray projects since Guthion is not registered for controlling these insects. However, research has shown Guthion to be effective at rates less than for coneworm control (DeBarr-personal communication); therefore, control of seed bugs is obtained also. The increase in sound seed produced no doubt is reflected in control of seed bugs.

Where seed efficiency was measured, only the Cygon-Guthion treatment at the Stuart and the east Ouachita source were above 50 percent. According to the Eastern Tree Seed Laboratory (unpublished report), if seed efficiency is below 50 percent, additional efforts may be required to increase seed yield. This at the federal orchards would be generally in the form of better spray coverage. This is the first year that most of the orchards have been treated with Guthion or Furadan. With two consecutive years of treatment, seed efficiency should increase since with treatment, fewer first year aborted ovules should be caused by seed bugs.

Verbal reports from seed orchard managers indicate an increase in coneworm and coneborer populations during 1977. The trend is likely to continue during 1978.

Tip moth losses were relatively low at all southern Federal seed orchards during 1976 and 1977. Also, data from studies on 16-year-old pine plantations in the South show negligible difference in height growth losses between trees protected from tip moth for the first 5 - 6 years and unprotected trees (Williston and Barras 1977). However at 6 years after planting of these shortleaf and loblolly pines, there was a significant

difference in height growth between treated and untreated trees (Beal 1967). From an entomological standpoint, it appears that tip moth control is not currently justified.

Although the Nantucket pine tip moth causes early conelet losses (Yates and Ebel 1972), no method is currently registered for protecting conelets from tip moth attack. Early treatments (March and April) with Cygon indicates that this treatment may even cause conelet abortion. Furadan and Guthion, as applied for cone and seed insects, should protect tips from tip moth attack for most of the season. Furadan is not currently registered for tip moth control and Guthion is registered for tip moth at lower rates (1 1/2 - 3 pints Guthion 2S/acre) than for coneworms and seedworms.

Little is known about the parasites and predators of any of the insects affecting pine seed production. From year to year there is little likelihood that natural biological agents will be able to reduce all species of seed and cone insects involved to a tolerable level.

RECOMMENDATIONS

1. Treat with Furadan or Guthion only those blocks of trees producing enough conelets or cones to justify treatment costs. Apply the treatment to enough acreage to supply the needed quantity of seed for each geographical seed source.

2. When Furadan is applied, use 4 oz (8 oz for control of conebeetle) of 10 percent granular per inch of tree diameter and apply with a Pow'r Till Seeder. For controlled pollinations, apply 8 oz/in. of tree dia. by hand and rake or disk in. Cover with 2 in. mulch, pine straw, or sawdust.

3. When Guthion is used, apply four applications (May, July, August, and September) at either 6 pints per 100 gal. (0.2% dilution) as a drench spray, or 30 pints per 100 gal. (1% dilution), applying one-fifth the volume needed for a drench spray. Thorough coverage of cones is necessary for maximum control.

4. Do not spray trees for tip moth control unless they are just being outplanted in an orchard. Controls should be applied during the first two growing seasons.

5. Increase from four to six the number of clones in your monitoring areas.

REFERENCES

Beal, R. H. 1967. Heavy tip moth attacks reduce early growth of loblolly and shortleaf pine. So. Forest Exp. Sta., Res. Note SO-54.

Ebel, B., T. H. Flavell, L. E. Drake, H. O. Yates, III, and G. DeBarr. 1975. Seed and Cone Insects of Southern Pines. USDA Forest Service, General Technical Report/SE-8.

Overgaard, N. A., L. E. Drake, and H. N. Wallace. 1974. Summary of seed orchard insect evaluations during 1973 by the Alexandria Field Office. USDA. For. Svc., S.E. Area, FI&DM, Report No. 74-2-5.

_____, H. N. Wallace, C. Stein, and G. D. Hertel, 1976. An Evaluation of Seed & Cone Insect Damage at the Erambert, Ouachita, and Stuart Orchards, in Mississippi, Arkansas, and Louisiana. U.S. Forest Service, SE Area, FI&DM, Report No. 76-2-12.

_____, L. E. Drake and T. H. Flavell. 1974. Seed Orchard Pest Management in the South, A Problem Analysis. SE Area, S&PF, Forest Service Report.

Williston, H. L., and S. J. Barras, 1977. Impact of tip moth injury on growth and yield of 16 year old loblolly and shortleaf pine. So. Forest Exp. Sta. Res. Note SO 221.

Yates, H. O. III, and B. H. Ebel. 1972. Shortleaf pine conelet loss caused by the Nantucket pine tip moth, Rhyacionia frustrana (Lepidoptera:Olethreutidae). Ann. Entomol. Soc. Amer. 65:100-4.